

## CLAIMS

What is claimed is:

1 1. A method for performing memory disambiguation in a compiler, comprising:  
2 determining memory objects corresponding to memory references in one or  
3 more source files being compiled;  
4 creating a memory disambiguation token for each memory reference, each  
5 memory disambiguation token identifying information particular to the memory  
6 reference it is associated with so as to preserve high-level and intermediate-level  
7 semantic information  
8 creating a symbolic memory reference representation associated with each  
9 memory disambiguation token, including information on whether the memory reference  
10 is indirect or direct and access to symbol table information for a pointer to the memory  
11 object for indirect references or the memory object for direct references; and  
12 determining if potentially dependent memory references are dependent or  
13 independent based on information contained in the disambiguation tokens for those  
14 memory references and their associated symbolic memory reference representations.

1 2. The method of claim 1, further comprising determining if memory references are  
2 redundant based on information contained in the disambiguation tokens for those  
3 memory references and their associated symbolic memory reference representations.

1 3. The method of claim 1, further comprising determining a relative difference in  
2 starting addresses for two memory references that are determined to be independent or  
3 dependent.

1 4. The method of claim 1, wherein the disambiguation token comprises a data  
2 structure including a plurality of links to data objects in which disambiguation  
3 information are stored

1 5. The method of claim 4, wherein the data structure is embedded in memory  
2 reference operators of an intermediate language produced during the compilation of  
3 said one or more source files.

1 6. The method of claim 1, wherein the disambiguation token associated with the  
2 memory object includes a key that is used to access a table of data dependence  
3 information.

1 7. The method of claim 1, wherein the disambiguation token contains a link to  
2 address base and offset information for the memory reference that is used for low-level  
3 disambiguation.

1 8. The method of claim 1, further comprising:  
2 substituting a direct memory reference for an indirect memory reference; and  
3 updating the disambiguation token corresponding to the memory reference to  
4 indicate the memory reference is now a direct memory reference.

1 9. The method of claim 1, further comprising using information identified by  
2 disambiguation tokens to determine sets of local memory objects that are not  
3 referenced after they are modified.

1 10. The method of claim 1, further comprising determining if two memory references  
2 access overlapping memory locations based on information contained in the

3 disambiguation tokens for those memory references and their associated symbolic  
4 memory reference representations.

1 11. The method of claim 10, further comprising determining particularities of an  
2 overlap between two overlapping memory references.

1 12. The method of claim 1, further comprising:  
2 determining the functions executed corresponding to function calls in the one or  
3 more source files being compiled;

4 creating a disambiguation token for each function call, each disambiguation  
5 token identifying information particular to the function call it is associated with so as to  
6 preserve high-level and intermediate level semantic information;

7 creating a symbolic function call representation associated with each  
8 disambiguation token, including information on whether the function call is indirect or  
9 direct and access to symbol table information for the pointer or function respectively;  
10 and

11 determining if potentially dependent calls and memory references are dependent  
12 or independent for the function calls based on information contained in the  
13 disambiguation tokens for the calls and memory references, their associated symbolic  
14 representation, an analysis of each function to determine the set of memory locations  
15 modified or referenced by the function.

1 13. The method of claim 1, wherein the disambiguation token contains a link to type  
2 information associated with the memory reference.

1 14. The method of claim 1, wherein the disambiguation token for an indirect memory  
2 reference contains a link to a set of memory objects accessible via the pointer as  
3 determined by points-to analysis.

1 15. The method of claim 1, further comprising using the disambiguation token and  
2 the symbolic memory reference representation as an interface or means of  
3 communication between various software components of a disambiguator that performs  
4 memory disambiguation functions and clients of the disambiguator.

1 16. A system comprising:

2 a memory in which a plurality of machine instructions comprising a compiler and  
3 programming code corresponding to one or more source files are stored; and

4 a processor coupled to the memory, executing the machine instructions to  
5 perform the functions of:

6 determining memory objects corresponding to memory references in said  
7 one or more source files;

8 creating a memory disambiguation token for each memory reference,  
9 each memory disambiguation token identifying information particular to the  
10 memory reference it is associated with so as to preserve high-level and  
11 intermediate-level semantic information

12 creating a symbolic memory reference representation associated with  
13 each memory disambiguation token, including information on whether the  
14 memory reference is indirect or direct and access to symbol table information for  
15 a pointer to the memory object for indirect references or the memory object for  
16 direct references; and

17 determining if potentially dependent memory references are dependent or  
18 independent based on information contained in the disambiguation tokens for

19 those memory references and their associated symbolic memory reference  
20 representations.

1 17. The system of claim 16, wherein execution of the machine instructions by the  
2 processor further performs the function of determining if memory references are  
3 redundant based on information contained in the disambiguation tokens for those  
4 memory references and their associated symbolic memory reference representations.

1 18. The system of claim 16, wherein execution of the machine instructions by the  
2 processor further performs the function of determining relative positions of starting  
3 addresses for memory references that are independent or dependent.

1 19. The system of claim 16, wherein execution of the machine instructions by the  
2 processor further performs the functions of:

3 substituting a direct memory reference for an indirect memory reference; and  
4 updating the disambiguation token corresponding to the memory reference to  
5 indicate the memory reference is now a direct memory reference.

1 20. The system of claim 16, wherein execution of the machine instructions by the  
2 processor further performs the function of using information identified by  
3 disambiguation tokens to determine sets of local memory objects that are not  
4 referenced after they are modified.

1 21. The system of claim 16, wherein execution of the machine instructions by the  
2 processor further performs the function of determining if two memory references access  
3 overlapping memory locations based on information contained in the disambiguation

4 tokens for those memory references and their associated symbolic memory reference  
5 representations.

1 22. The system of claim 16, wherein execution of the machine instructions by the  
2 processor further performs the functions of:

3 determining the functions executed corresponding to function calls in the one or  
4 more source files being compiled;

5 creating a disambiguation token for each function call, each disambiguation  
6 token identifying information particular to the function call it is associated with so as to  
7 preserve high-level and intermediate level semantic information;

8 creating a symbolic function call representation associated with each  
9 disambiguation token, including information on whether the function call is indirect or  
10 direct and access to symbol table information for the pointer or function respectively;  
11 and

12 determining if potentially dependent calls and memory references are dependent  
13 or independent for the function calls based on information contained in the  
14 disambiguation tokens for the calls and memory references, their associated symbolic  
15 representation, an analysis of each function to determine the set of memory locations  
16 modified or referenced by the function.

1 23. An article of manufacture on which a plurality of machine instructions comprising  
2 a compiler are stored that upon execution of the machine instructions by a processor  
3 causes the functions to be performed, including:

4 determining memory objects corresponding to memory references in said one or  
5 more source files;

6 creating a memory disambiguation token for each memory reference, each  
7 memory disambiguation token identifying information particular to the memory

8 reference it is associated with so as to preserve high-level and intermediate-level  
9 semantic information

10 creating a symbolic memory reference representation associated with each  
11 memory disambiguation token, including information on whether the memory reference  
12 is indirect or direct and access to symbol table information for a pointer to the memory  
13 object for indirect references or the memory object for direct references; and

14 determining if potentially dependent memory references are dependent or  
15 independent based on information contained in the disambiguation tokens for those  
16 memory references and their associated symbolic memory reference representations.

24. The article of manufacture of claim 23, wherein execution of the machine  
instructions further performs the function of determining if memory references are  
redundant based on information contained in the disambiguation tokens for those  
memory references and their associated symbolic memory reference representations.

25. The article of manufacture of claim 23, wherein execution of the machine  
instructions further performs the function of determining relative positions of starting  
addresses for memory references that are independent or dependent.

26. The article of manufacture of claim 23, wherein execution of the machine  
instructions further performs the functions of:

substituting a direct memory reference for an indirect memory reference; and  
updating the disambiguation token corresponding to the memory reference to  
indicate the memory reference is now a direct memory reference.

27. The article of manufacture of claim 23, wherein execution of the machine  
instructions further performs the function of using information identified by

3 disambiguation tokens to determine sets of local memory objects that are not  
4 referenced after they are modified.

1 28. The article of manufacture of claim 23, wherein execution of the machine  
2 instructions further performs the function of determining if two memory references  
3 access overlapping memory locations based on information contained in the  
4 disambiguation tokens for those memory references and their associated symbolic  
5 memory reference representations.

1 29. The article of manufacture of claim 23, wherein execution of the machine  
2 instructions further performs the functions of:

3 determining the functions executed corresponding to function calls in the one or  
4 more source files being compiled;

5 creating a disambiguation token for each function call, each disambiguation  
6 token identifying information particular to the function call it is associated with so as to  
7 preserve high-level and intermediate level semantic information;

8 creating a symbolic function call representation associated with each  
9 disambiguation token, including information on whether the function call is indirect or  
10 direct and access to symbol table information for the pointer or function respectively;  
11 and

12 determining if potentially dependent calls and memory references are dependent or  
13 independent for the function calls based on information contained in the disambiguation  
14 tokens for the calls and memory references, their associated symbolic representation,  
15 an analysis of each function to determine the set of memory locations modified or  
16 referenced by the function.



Isotope	Half-life	Decay mode	Decay energy (MeV)	Decay constant ( $\lambda$ ) ( $s^{-1}$ )	Activity (Bq)	Activity (Ci)
$^{131}\text{I}$	8.02 d	$\beta^-$	0.191	$8.02 \times 10^6$	1.00	2.70 $\times 10^{-8}$
$^{132}\text{I}$	2.30 h	$\beta^-$	0.220	$1.04 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{133}\text{I}$	20.8 h	$\beta^-$	0.141	$4.44 \times 10^5$	1.00	2.70 $\times 10^{-8}$
$^{134}\text{I}$	4.77 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{135}\text{I}$	9.9 h	$\beta^-$	0.191	$8.02 \times 10^5$	1.00	2.70 $\times 10^{-8}$
$^{136}\text{I}$	8.37 d	$\beta^-$	0.191	$8.02 \times 10^6$	1.00	2.70 $\times 10^{-8}$
$^{137}\text{I}$	32.8 h	$\beta^-$	0.141	$4.44 \times 10^5$	1.00	2.70 $\times 10^{-8}$
$^{138}\text{I}$	10.5 min	$\beta^-$	0.220	$1.04 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{139}\text{I}$	1.83 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{140}\text{I}$	1.23 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{141}\text{I}$	0.81 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{142}\text{I}$	0.69 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{143}\text{I}$	0.57 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{144}\text{I}$	0.47 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{145}\text{I}$	0.39 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{146}\text{I}$	0.32 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{147}\text{I}$	0.26 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{148}\text{I}$	0.21 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{149}\text{I}$	0.17 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{150}\text{I}$	0.14 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{151}\text{I}$	0.11 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{152}\text{I}$	0.09 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{153}\text{I}$	0.07 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{154}\text{I}$	0.06 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{155}\text{I}$	0.05 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{156}\text{I}$	0.04 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{157}\text{I}$	0.03 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{158}\text{I}$	0.02 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$
$^{159}\text{I}$	0.01 h	$\beta^-$	0.220	$3.98 \times 10^4$	1.00	2.70 $\times 10^{-8}$